SA-392

CIVIL AERONAUTICS BOARD

File No. 1-0001

AIRCRAFT ACCIDENT REPORT

ADOPTED: March 28, 1967 **RELEASED:** April 4, 1967

AMERICAN FLYERS AIRLINE CORPORATION
L-188C, N183H,
NEAR ARDMORE MUNICIPAL AIRPORT
ARDMORE, OKLAHOMA
APRIL 22, 1966

SYNOPSIS

An American Flyers Airline Corporation, Lockheed Electra L-188C, N183H, operating as CAM Flight 280/D, crashed 1-1/2 miles northeast of the Ardmore Municipal Airport, Ardmore, Oklahoma, at 2030 c.s.t., April 22, 1966. There were 92 revenue passengers, one non-revenue passenger (a company employee), and five crewmembers aboard the aircraft. Of these persons, 18 revenue passengers initially survived the accident; however, three of the survivors subsequently died. The aircraft was destroyed by impact and subsequent fire.

Flight 280/D, scheduled as a domestic Military Airlift Command contract Civil Air Movement charter flight, departed the Monterey Peninsula Airport, Monterey, California, at 1632 c.s.t., en route to Columbus, Georgia, with a scheduled refueling stop at Ardmore, Oklahoma. The crew was attempting a visual, circling approach to runway 30 at Ardmore after missing an ADF instrument approach to runway 8, when the aircraft struck a hill at an elevation of 963 feet. The airport elevation was 762 feet m.s.l. The last weather report furnished the crew was: 700 broken, 1100 overcast, visibility 3 miles, very light rain showers, fog, wind 130° at 6 knots. The ceiling was ragged.

The Board determines the probable cause of this accident was the incapacitation, due to a coronary insufficiency, of the pilot-in-command at a critical point during a visual, circling approach being conducted under instrument flight conditions.

1. INVESTIGATION

1.1 History of Flight

American Flyers Airline Corporation (AFAX) Flight 280/D, a Lockheed Electra L-188C, N183H, crashed 1-1/2 miles northeast of the Ardmore Municipal Airport, Ardmore, Oklahoma, at 2030[1/] April 22, 1966. Of the 92 revenue passengers, one non-revenue passenger (a company employee), and five crewmembers aboard, 18 revenue passengers survived, however, three of them later succumbed to injuries. The aircraft was destroyed by impact and subsequent fire.

1/ All times herein are central standard based on the 24-hour clock unless otherwise indicated.

The crew of Flight 280/D reported for duty to the Ardmore AFAX operations at 0430 on the morning of April 22, 1966. The flight was scheduled to fly: a ferry flight from Ardmore to Lawton, Oklahoma; a Civil Air Movement (CAM) Flight 262/D (Military Charter) to McChord AFB, Washington, a ferry flight to Monterey, California; and CAM Flight 280/D to Columbus, Georgia, with a crew change and refueling stop at Ardmore, the AFAX Maintenance Base.

The ferry flight to Lawton departed Ardmore at 0603 and arrived at 0639.[2/] At departure, the crew consisted of two captains, a first officer, one engineer, and two flight attendants.

Flight 262/D departed Lawton at 0732 and arrived at McChord at 1204.

A U. S. Air Force weather officer stationed at McChord stated that at approximately 1230 (1030 P.s.t.), he gave a civilian pilot a weather briefing from McChord to Monterey, and from Monterey to Ardmore, Oklahoma.

The weather officer provided an outlook for the route from Monterey to Ardmore which indicated that the flight would encounter no significant weather until it reached eastern New Mexico. He gave the pilot the current military weather warning advisory which indicated that en route to Ardmore, the flight would be flying into an area of forecast maximum thunderstorm intensity.

The pilot requested the forecast for Ardmore. Since there was no terminal forecast prepared for Ardmore, the weather officer gave him the Tinker AFB, Oklahoma, the Sheppard AFB, and Perrin AFB, Texas terminal forecasts for conditions at his expected arrival time at Ardmore. The pilot copied the forecasts and departed.

Departure from McChord for the ferry flight to Monterey was at 1344 with arrival at 1535. The total flight time from Ardmore to Monterey was 6 hours and 59 minutes.

Upon arrival at Monterey, the only mechanical writeup entered on the flight log was "Auto pilot altitude hold inop." The engineer signed the item off by writing: "OK to continue."

The dispatching of Flight 280/D from Monterey was accomplished by a telephone call to the company's dispatcher at Ardmore Municipal Airport. The telephone message gave the flight plan as follows: Flight 183H (CAM 280/D), estimated time of departure 1630; estimated time en route 3 hours and 45 minutes with Dallas, Texas, as the alternate. Total number of passengers was 92 with an actual passenger weight of 14,891 pounds. Existing weather at Ardmore was 1,100 feet overcast, 4 miles visibility in light rain. Forecast weather was 1,100 feet overcast, 3 miles visibility in light rain. The flight plan was a composite VFR/IFR via Jet Airway 110/Jet Airway 76 to Amarillo VOR, direct to Altus VOR, direct to the Ardmore VOR.

The U. S. Navy weather service stated that no weather briefing was provided the flight crew of Flight 280/D on April 22, 1966, by its facility at Monterey.

2/ All takeoff and landing times are derived from the AFAX Flight Data Log.

The weight and balance form prepared by the crew showed the takeoff weight to be 110,125 pounds, well under the maximum of 160,000 pounds. The maximum landing weight was 95,650 pounds and the computed landing weight was 92,625 pounds. The center of gravity (c.g.) was computed to be within limits both at takeoff and at the time of the accident.

A new flight engineer boarded the aircraft at Monterey and the original engineer returned as a non-revenue passenger occupying the jump seat on departure from Monterey. Since there was room for only 93 passengers and five crewmembers aboard the aircraft, one of the two captains returned to Ardmore via commercial air transportation. He stated: "The aircraft, when I left it, was functioning normally on all systems with nothing having a squawk on it other than number one engine power lever being forward one inch from the others at about 1,000 to 1,500 hp., but all levers at flight idle showing zero hp. and no NTS.3/ In my opinion, it was in excellent condition." There was no log entry regarding the No. 1 power lever.

About the crew, the captain stated: "The crew's appearance, physically, mentally and personally was excellent, with all in a very good frame of mind during the time from Ardmore until I left them at Monterey."

Flight 280/D departed Monterey Peninsula Airport at 1632. The flight climbed to FL 215 4/ and operated under Visual Flight Rules.

At 1807, the aircraft's radar target was observed 45 miles west-northwest of Tuba City, Arizona, and the Denver Air Route Traffic Control Center (ARTCC) issued the following IFR clearance to Flight 280/D: Cleared to the Ardmore Airport, direct Tuba City, J76 Airway to Las Vegas, New Mexico, direct to Amarillo, direct Altus, direct Ardmore, to maintain FL 210.

After passing Tuba City, the crew requested and received clearance to deviate south of course because of cloud buildups. At approximately 1839, control of the flight was transferred from the Denver to the Albuquerque ARTCC following a radar handoff. At the crew's request, clearance was then issued for the flight to descend to and maintain FL 190. At approximately 1905, when approaching Las Vegas, New Mexico, the flight requested and received the 1900 Dallas and Ardmore weather from the Flight Service Station (FSS) at Las Vegas. The Ardmore 1857 weather was: balloon ceiling, 600 feet overcast, visibility 1¼ miles in light rain showers and fog, temperature 63°F., dewpoint 63°F., wind from 110° at 6 knots, and the altimeter setting was 30.06 inches.

3/ Zero hp. indicates that all horsepower indicators on the four engines returned to zero when the power levers were retarded to their flight idle stops. The NTS control system is a safety system by which the propeller blade angle is increased as necessary to limit negative propeller shaft torque.

4/ Flight levels above 18,000 feet are stated in three digits that represent hundreds of feet. For example FL 215 represents a barometric altimeter indication of 21,500 feet using a reference datum of 29.92 inches of mercury as an altimeter setting.

En route to Amarillo, Flight 280/D was vectored by Albuquerque ARTCC around and between several areas of precipitation echoes.

Shortly after passing the Amarillo VORTAC at 1942, control of the flight was transferred from the Albuquerque to the Fort Worth ARTCC. At 2003, when approximately 10 miles northwest of Altus VOR, the crew of Flight 280/D requested a lower altitude and was cleared to descend to and maintain 7,000 feet.

At 2005, the Fort Worth ARTCC received a request from the crew of Flight 280/D to proceed direct to Duncan VOR, direct to the Ardmore radio beacon. This routing was approved and the flight reported leaving 17,000 feet. The flight was then advised of the precipitation echoes beginning 15 miles west of the Ardmore VOR.

At approximately 2006, the crew of Flight 280/D contacted the Ardmore FSS and advised the FSS specialist of their estimated time of arrival as 2028, and requested the current Ardmore weather. The 1957 weather observation was then given to the crew. This weather was: A measured ceiling of 800 feet overcast; visibility 2 miles in very light rain showers and fog; temperature 63°F; dewpoint 63°F; wind from 120 at 5 knots; and the altimeter setting was 30.05 inches. A thunderstorm began at 1912 and ended at 1920 with no wind gust reported.

At 2007, 2008, and 2010, the Fort Worth ARTCC controller attempted to contact Flight 280/D and, on the last attempt, radio contact was re-established, and the crew reported leaving 12,000 feet. The flight was then cleared to descend to 5,000 feet and reported level at that altitude at 2016.

At 2018, the crew of Flight 280/D advised Fort Worth ARTCC they were 30 miles west of the Ardmore VOR and requested a lower altitude. Fort Worth ARTCC cleared the flight to the Ardmore Airport to continue to cruise at 5,000 feet. Radar service was terminated and the crew was advised to contact the Ardmore FSS.

At approximately 2020, the crew contacted Ardmore Radio and requested the runway lights on runway 8 to be turned on. The FSS specialist changed the lights from runway 12 to runway 8 and advised the flight to stand by as he was making a special weather observation. Shortly thereafter, he transmitted his 2020 weather observation to the flight. This Special Observation was: a measured ceiling of 700 feet broken clouds; and overcast at 1,100 feet; visibility 3 miles in very light rain showers and fog; the wind was from 130° at 6 knots; and the altimeter was 30.06 inches. The ceiling was reported to be ragged.

At approximately 2026, the FSS specialist requested Flight 280/D's position. The crew advised they were over the Ardmore radio beacon inbound. Surface wind information and altimeter setting were given to the flight.

Approximately two minutes later, the FSS specialist observed the lights of an aircraft north of the airport moving in an easterly direction. Moments later, at 2029, the crew of Flight 280/D contacted him and requested the runway lights be changed to runway 12. He actuated the selector switch, made a visual check to verify that the lights were operating, and returned to his normal position in the facility. At 2030, he looked out his east window and observed a "fire ball" some distance northeast of the airport. No answers were received to his attempts to contact Flight 280/D, and he then alerted the fire station and advised them that he thought the flight had crashed northeast of the airport.

Witnesses located along the route of flight stated that the aircraft passed approximately one mile to the north of the Ardmore beacon, then followed a path to a point approximately 1-3/4 to 2 miles north of the approach end of runway 8. Calculations made with the witnesses' assistance and Abney Level readings of their recollection of the position of the aircraft, as well as their observations of a series of fly-bys (See Sect. 1.15) indicated that the aircraft was at approximately 1,160 feet m.s.l., when it passed north of the airport (see Attachment No. 1). Several persons located on Ardmore Municipal Airport observed the lights of the aircraft as it continued on a northeasterly course.

Interviews with the surviving passengers revealed that they had little or no recollection of the accident. Most of them were asleep at the time of impact. One survivor did recall a turn to the left before the impact, and another testified that following a series of turns the aircraft turned sharply to the left and the engine sounds increased markedly just before impact. None of the survivors recalled the aircraft nosing over, diving, or feeling any negative "g".

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	5	78*	0
Non-fatal	0	15	0
None	0	0	

* One non-revenue passenger included.

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

There was property damage to livestock and trees in the wreckage area.

1.5 Crew Information

Captain Reed W. Pigman, age 59, was founder and president of American Flyers Airline Corporation. He had a total of 16,247 flying hours, of which 1,247 hours were in the L-188. He held airline transport pilot certificate No. 16711 with type rating in the DC-3, DC-4, and L-188. He had flown 60 hours in the 90 days preceding the accident of which 8 hours were logged as instrument time and 12 hours were at night. He had flown 18 hours in the last 30 days, of which 2 hours were at night. He had logged no instrument time in the last 30 days. He had completed proficiency and line checks on February 4, 1965, and September 26, 1965, respectively. His first-class medical certificate dated February 22, 1966, specified that he must wear glasses while flying.

First Officer William A. Marr, age 49, was employed by AFAX on March 29, 1965. He had a total of 12,335 flying hours, of which 1,155 were in the L-188. He held airline transport pilot certificate No. 410321, with a type rating in DC-3 and commercial privileges for airplane single and multiengine land and sea. He had flown 225 hours in the 90 days preceding the accident, of which 23 hours were

instrument time and 47 hours were at night. He had flown 75 hours during the last 30 days, of which 2 hours were instrument time and 16 hours were at night. His last en route inspection was conducted February 9, 1966. His first-class medical certificate was dated March 1, 1966, with the stipulation that he must possess glasses for near vision.

Flight Engineer Charles M. Gray, age 34, was employed by AFAX from May 1960 until August 1961 and was rehired by AFAX on September 17, 1962. He had a total of 4,378 flying hours, 2,546 of which were in the L-188. He held flight engineer certificate No. 14553345 and airframe and powerplant certificate No. 1307904. He had flown 230 hours in the 90 days preceding the accident and 55 hours in the last 30 days. His last annual proficiency check was accomplished on February 2,1966. He had been designated by the Federal Aviation Agency (FAA) as a Flight Engineer Check Airman on L-188 equipment as of March 22, 1966. His second-class medical certificate was dated September 21, 1965, with no limitations.

Flight Attendant Wanda F. Stonecipher, age 23, was employed by AFAX on November 15, 1964. She compleded stewardess training on January 12, 1965, and her last recurrent emergency training was accomplished on January 15, 1966.

Flight Attendant Dyanna J. Duncan, age 23, was employed by AFAX on August 3, 1965. She completed stewardess training on August 20, 1965, and her last recurrent emergency training was accomplished on November 10, 1965.

Flight Engineer Anthony A. Pica, assigned as the flight engineer on the flights from Ardmore to Monterey, was returning to Ardmore as a non-revenue passenger and was seated in the jump seat.

For April 22, 1966, the crew duty time of Captain Pigman and First Officer Marr was 16 hours, and Flight Engineer Gray's crew duty time was 5 hours and 30 minutes. Since there were three pilots from Ardmore to Monterey, Captain Pigman and First Officer Marr logged a total of 7 hours and 25 minutes of flight time for the entire day.

1.6 Aircraft Information

N183H, a Lockheed Electra L-188C, Serial No. 1136, was owned and operated by American Flyers Airline Corporation, Continental National Bank Building, Fort Worth, Texas. The aircraft was manufactured in 1962 by Lockheed Aircraft Corporation and purchased by AFAX on March 2, 1963. It had a total time of 4,019:06 hours and had four Allison model 501-D13A engines installed as follows:

Position	Serial No.	TSO	T.T.
1	501376	3044:40	3044:40
2	501383	128:29	3118:59
3	501377	1236:01	3621:38
4	501462	773:30	6206:30

The propellers installed were Hamilton Standard model 54-H-60:

Position	Serial No.	TSO	T.T.
1	216510	1256:37	1257:37
2	216515	128:29	128:29
3	216775	1236:01	1236:01
4	216856	409:44	409:44

The last "P" or 300-hour inspection was completed at Ardmore, Oklahoma, on April 22, 1966. The last service check or 75-hour inspection, and daily inspection was completed on April 22, 1966, at Ardmore, Oklahoma. The aircraft was flown 10:49 hours since its last "P" inspection prior to the occurrence of this accident. A review of the aircraft records indicated that a total of fifteen aircraft components had been operated in excess of their authorized time limits on previous flights. These components had been replaced prior to the time of the accident.

An examination of flight log sheet No. 2592, dated April 22, 1966, covering the trip from Monterey to Ardmore revealed the following discrepancy entered on the aircraft log: "Disconnected left engine driven compressor low oil pressure light on." This is one of the two compressors that provide cabin pressurization. The lack of this compressor does not affect normal aircraft operation.

1.7 Meteorological Information

Meteorological information relevant to the weather existing in the Ardmore area was as follows:

The 2100 surface weather chart showed a warm front extending southwestward from southwestern Kentucky to near San Antonio, Texas, and a trough extending southwest from northwestern Illinois to near Wichita Falls, Texas.

The 2043 Ardmore local weather observation was in part as follows: Measured 700 feet overcast, visibility 2 miles in light rain showers and fog, temperature 63°F., dewpoint 63°F., wind from 120 degrees at 7 knots, altimeter setting 30.07 inches.

The 2043 Fort Worth radar weather observation was in part as follows: Broken area of echoes containing light rain showers and thunderstorms producing light rain showers, decreasing slowly in intensity, area bounded by 297 degrees 78 miles from the antenna, 088 degrees 139 miles, 065 degrees 179 miles, 120 degrees 13 miles, moving from 220 degrees 30 knots, top of detectable moisture 20,000 feet m.s.l.

The 2045 Oklahoma City radar weather observation was in part as follows: Broken area of echoes containing light rain showers and thunderstorms producing moderate rain showers, increasing in intensity, area bounded by 060 degrees 125 miles from the antenna, 085 degrees 125 miles, 160 degrees 100 miles, 188 degrees 90 miles, 115 degrees 50 miles of cells 10 miles, moving from 260 degrees 20 knots, top of detectable moisture 25,000 feet m.s.l. includes a solid line of echoes containing thunderstorms producing moderate rain showers located from 115 degrees 50 miles from the antenna to 188 degrees 90 miles, 12 miles wide, top of detectable moisture 35,000 feet m.s.l.

A radar scope photograph made by the National Servere Storms Laboratory at Norman, Oklahoma, about the time of the accident showed an isolated echo, containing heavy rain showers and probably a thunderstorm, centering between the Ardmore Radio Beacon and the airport. The diameter of the echo was approximately four nautical miles, and it was moving northeastward at about 35 knots.

The nearest winds aloft observations were taken at Oklahoma City and Fort Worth at 1800 and are in part as follows:

	Height	Direction	Velocity
Fort Worth	1,000 (ft. m.s.l.)	160 (degrees, true)	18 (knots)
	2,000 (ft. m.s.l.)	170 (degrees, true)	27 (knots)
	3,000 (ft. m.s.l.)	180 (degrees, true)	34 (knots)
Oklahoma City	2,000 (ft. m.s.l.)	010 (degrees, true)	11 (knots)
	3,000 (ft. m.s.l.)	050 (degrees, true)	8 (knots)

At approximately 2006, while descending to 7,000 feet, the crew of Flight 280/D was advised by Fort Worth ARTCC controller: "For your information, we're painting a little line of cell activity beginning fifteen west of Ardmore running northeast from that position."

Flight 280/D acknowledged: "If you'll keep us advised."

At 2016, while Flight 280/D was en route from Amarillo to Ardmore and in a descent to 5,000 feet, the Fort Worth ARTCC controller gave the following weather data to the flight which was acknowledged:

"Ardmore weather measured eight hundred overcast, two miles, light rain and fog, winds one two zero degrees at five knots. I have what appears to be a line running northeast and southwest twenty miles west of Ardmore running on a line about fifty miles long."

Several witnesses located northwest of the Ardmore Radio Beacon described light, and in one instance, heavy rain showers near the time of the accident. One witness, located between the radio beacon and the airport, described the aircraft as "lower than most" airplanes that pass his home. The noise of the aircraft, which he described as that of an "Electra", brought him outside his home but he could not see it. After he returned to his house, he heard a loud clap of thunder and heavy rain began to fall. Witnesses located at or near the Ardmore Municipal Airport described light rain prior to the aircraft passing, followed immediately by heavy rain showers after the aircraft passed low over their location. They described a ragged cloud base to the north.

1.8 Aids to Navigation

The Ardmore Municipal Airport had a designated control zone, and there were three published instrument approach procedures prescribed for the facility. These were an ADF, a VOR, and a VOR/DME approach. Ground certification checks of the NAVAID facilities associated with these approaches were begun at 2130 on the night of the accident. Checks were made of the VOR, The TACAN/DME, the Low Frequency Radio Beacon, the associated monitor equipment for NAVAIDS, and the VHF communications (FSS Frequencies). These facilities were found to be operating within established tolerances, and no adjustments to the equipment were required.

The FAA approved instrument procedure for a straight-in ADF approach to the Ardmore Municipal Airport, with a transition from the Duncan VOR, is via a magnetic track of 088 degrees to the Ardmore Radio Beacon. The minimum altitude between Duncan and Ardmore is 2,600 feet and the minimum crossing altitude at the Ardmore Radio Beacon is 2,300 feet. The magnetic track from the radio beacon to the runway is 076 degrees. The missed approach procedure requires a climb to 2,700 feet on a course of 076 degrees magnetic within 20 miles of the airport. The weather minima applicable to this type of aircraft, at night, for a straight-in approach to runway 8 were ceiling 600 feet and visibility one mile. Circling minimums at night were 600 feet (m.s.l. value 1,362) and 1-1/2 miles. Field elevation is 762 feet m.s.l. There were no radar services associated with the Ardmore Municipal Airport.

AFAX training procedures for an ADF approach in Electra equipment required the before-landing checklist be accomplished prior to leaving the final approach fix, with the exception of landing gear extension. Normally, approach flaps would be lowered and once over the fix, the landing gear would be placed in the down position unless the fix is over three miles from the airport, in which case the landing gear would be placed in the down position when one minute from the airport.

1.9 Communications

Air-ground communications were routine except for the failure of the crew of Flight 280/D to respond to calls on 133.9 mcs. from the Fort Worth ARTCC, an assigned frequency that should have been guarded while the flight was under the Center's control. A period of 2 minutes and 25 seconds elapsed before communications were re-established with the Center. During this time, the first officer was in contact with the Ardmore FSS specialist on frequency 126.7 mcs. obtaining weather information. The first officer did reply to the Center after he terminated his conversation with Ardmore FSS.

Individuals familiar with the voices of the crew of Flight 280/D listened to the recording of the communications between the Fort Worth ARTCC and this flight and identified the first officer as the person who was making the transmissions. The Ardmore FSS specialist stated that the voice he heard on the above recording was the same person that communicated with his station. He could not identify the person, but stated that it was not the voice of the captain, whose voice he would have recognized.

1.10 Aerodrome and Ground Facilities

The Ardmore Municipal Airport had no functioning control tower. However, the FSS was located on the airport, and provided aircraft landing information. The airport is equipped with two lighted runways for use at night and two other runways that are unlighted. The airport is also equipped with a green and white rotating beacon and blue taxiway lights. The rotating beacon and runway lights on runway 8/26 and 12/30 were operational and in use on the night of the accident. Runway 8/26 was equipped with low-intensity 30 watt lights and runway 12/30 with high-intensity 200 watt lights.

When the crew of Flight 280/D requested the lights on runway 8 at 2020, the FSS specialist changed the lights from runway 12, the runway which the existing

wind favored. At 2029, the crew of Flight 280/D requested the lights be changed to runway 12. The FSS specialist immediately switched off the lights on runway 8 and turned on the lights on runway 12. In each instance, the lights of the appropriate runway were observed to be lit.

1.11 Flight Recorder

An LAS model 109C flight data recorder, serial No. 968, conforming to FAA TSO-C51, manufactured by the Special Devices Division of the Lockheed Aircraft Service Company, Ontario, California, was installed aboard Flight 280/D. The recorder assembly was recovered intact at the accident scene.

An examination of the recorder assembly revealed that the engaging tangs of the pawl assembly were loose in the recorder housing. The pawl assembly disclosed a foreign substance determined to be from a white paperback pressure sensitive tape. Because the recorder foil drive system is dependent upon proper installation of the pawl the absence of the two engaging tangs disables the drive system. Examination of the recorder foil disclosed that it had only advanced a minute amount and was not advancing prior to or at the time of impact. Approximately 3/4 roll of unused foil remained on the supply spool at the time of removal. No readout of the altitude, indicated airspeed, vertical acceleration, or magnetic heading, during the last flight could be made.

The operating procedure[5/] for the flight recorder required it to operate continuously from the instant the airplane commenced the takeoff roll until it had completed the landing roll. The AFAX procedures also required the flight engineer to check the operation of the recorder on each leg by listening to the test tone signal through the interphone system.

1.12 Wreckage

Flight 280/D crashed in the foothills of the Arbuckle Mountains approximately 1½ miles northeast of the Ardmore Municipal Airport.[6/] The wreckage was scattered along a line approximately 150 degrees magnetic, and all the major components of the aircraft were recovered in the wreckage area. There was no evidence of any inflight separation of structural components, in-flight fire, or lightning damage found on the recovered wreckage.

The first evidence of impact was a mark on a tree at approximately 963 feet m.s.l., on the right side of the wreckage pattern. Next were propeller slash marks in a leaning tree at an elevation of 958.8 and 960.6 feet m.s.l. These marks were 45 inches apart. Metal fragments and rivets were found in another tree near the propeller slash marks, and these fragments were identified as being part

5/ Federal Aviation Regulation Sec. 121.343(b) states: "Whenever an approved flight recorder is installed, it must be operated continuously from the instant the airplane begins the takeoff roll until it has completed the landing roll at an airport." Section 5 of the AFAX FAA approved Operations Manual has, in essence, the same stipulation. In the event of an in-flight failure of the recorder, the aircraft may continue only to the next stop where repairs or replacements can be made.

6/ The coordinates of the wreckage site are 34°19'45.54" West Latitude 96°58'54.57" North Longitude.

of the right wing. Ground scars made by first the right main and then the left main landing gears were followed by more propeller slash marks. The gouges associated with the two engines on the right wing, Nos. 3 and 4, were examined and the first evidence of fire was seen in the scar made by the No. 3 engine. Approximately 300 feet from the first impact marks the remaining portion of the right wing was found. The aircraft came to rest approximately 750 feet from the initial impact. There was evidence of ground fire in this area and most of the remaining wreckage was consumed by this fire except the empennage section from fuselage station 1117 aft.

All of the flight controls, trim tabs and landing flaps were accounted for in the wreckage area. Examination of the flight control system revealed that the overcenter links for both the rudder and elevators were in position for normal, boost on, operation. There was no evidence found to indicate any pre-impact malfunction of the flight control systems. Measurements of the landing flap screwjacks showed that they corresponded to a flap down position of 78 percent flaps. Trim tab settings could not be established due to damage to the system and its components.

All three landing gears separated from the aircraft and were recovered in the wreckage area. All three actuating cylinders were in the retracted position which corresponds to a gear-down condition for the landing gears.

Utilizing propeller-blade shim-plate impact angles, a density altitude of 1,000 feet, and a true airspeed of 150 knots, the following horsepower values were calculated from the engine/propeller curves:

Position	Blade Angle Degree	Horsepower
1	32	1,750
2	36	2,914
3	30	1,237
4	35	2,613

Cockpit Turbine Inlet Temperature (TIT) gauges read:

Position	Temperature (C^o)	Approximate Horsepower
1	696	1,281
2	732	1,600
3	745	1,684
4	678	1,164

There was no evidence of pre-impact operational distress noted in the examination of the engines and propellers.

The four powerplant exciter pickups were milled by their respective torquemeter exciter teeth. The exciter teeth of the four torquemeter shafts were displaced in the normal direction of torque. All compressor sections ingested dirt and debris. Compressor blades were bent in a direction opposite to normal rotation in all engines. The thermocouples, turbine inlet vanes, and turbine blades were coated with an aluminum deposit. The melting point of aluminum is 676.7°C. Powerplant examination revealed no evidence of overtemperature or other operational distress. All fuel-control electrically actuated shutoff valves were found in the "open" position.

1.13 Fire

The first evidence of fire occurred in the area of the No. 3 engine ground impact crater, which was located 82 feet from the initial impact. Three other areas of ground fire damage were evident farther along the wreckage distribution area.

Firefighting equipment and personnel from the Ardmore Municipal Airport extinguished whatever fires remained following the moderate rain showers which began immediately after the accident occurred.

1.14 Survival Aspects

The aircraft struck just below the crest of a hill, proceeded over the top of the hill, and slid down a slight grade for a distance of approximately 800 feet. Most of the passenger seats separated from the aircraft and tumbled out onto the ground during the last 150 feet of aircraft travel. Eighteen survivors were removed from the wreckage. Ten of them were found in the last 150 feet of the wreckage area. Two other survivors had hiked out of the accident area and six were found in a group approximately 50 yards south of the wreckage area.

Of the eighteen survivors, three later succumbed to the injuries they received in the accident.

All of the fatalities resulted from injuries sustained during the crash. Toxicological specimens from 63 passengers were sent to the Armed Forces Institute of Pathology for a carbon monoxide determination. Of these specimens only 12 cases showed evidence of carboxyhemoglobin in excess of 10 percent with the maximum being 45 percent.

1.15 Tests and Research

On May 4, 1966, a series of flights were conducted with an L-188 to attempt to establish an accurate flightpath with the assistance of witnesses who either saw or heard the aircraft on April 22, 1966. Five flights were made during daylight hours and two were conducted after dark. All flights were conducted during clear weather, and at 160 knots indicated airspeed.

In general, all flights began from an altitude of 2,300 feet at a point one mile north of the Ardmore Radio Beacon and descended to an elevation of approximately 1,160 feet m.s.l., in the area of the wreckage site.

The consensus of the witnesses was that the aircraft noise of the test aircraft was never as loud as that of Flight 280/D on April 22, 1966, and that most of the flights were conducted at too high an altitude. Witnesses agreed that the probable route of flight was over a point one mile north of the Ardmore Beacon, then on a magnetic heading of approximately 071 degrees until at a point approximately one mile north of the Ardmore Municipal Airport, at which time a turn to the right was begun.

1.16 Medical Investigation

Autopsies were performed on the three flight crewmembers and the causes of death were: Captain, either multiple injuries or coronary artery arteriosclerooses; First Officer, injuries; and the Flight Engineer, injuries. In view of the

findings as to the cause of death of the captain, an investigation was made into his medical history.

The autopsy protocol of the captain stated he had severe arteriosclerosis with calcification and brittleness of the coronary arteries. Microscopic examination of the heart revealed microscopic foci of fibrocytes with brown pigment laden macrophages and a few lymphocytes. There were also areas of bands of pink acellular scar tissue and mild focal perivascular fatty infiltration. The myocardium for the most part was free of scarring and no fresh infarcts were demonstrable.

There was a fracture of the right ulna, (large bone of the forearm) a fracture of the left lateral epicondyle, (outer elbow) and a fracture of the left index and ring fingers. Additionally, there were fractures of the skull, both legs, multiple rib fractures and internal injuries.

Post-mortem examination of the copilot revealed in addition to other injuries, a comminuted fracture of the right humerus; a comminuted fracture of the right ulnar and radial bones, proximal third; fractures of the metacarpal head of the thumb of the right hand; a compound comminuted fracture of the left thumb; and a fracture dislocation through the medial epicondyle.

Autopsies of the other crewmembers revealed traumatic injuries consistent with severe decelerative forces experienced during the accident. There was no evidence of pre-existing diseases which would render them incapable of performing their duties.

The pathologist who performed the autopsy testified at the public hearing to amplify the remarks of the autopsy protocol. He testified that his examination of the captain's heart revealed "severe and very vast coronary arteriosclerosis which, because of the severity, precluded cutting or sectioning at the scene" (of the autopsy). He described arteriosclerosis of the coronary arteries as a disease process which causes narrowing of the lumens through which the blood flows, and slows and precludes the carrying of a full volume of blood which carries the oxygen to the heart. The gross impression of severe coronary artery arteriosclerosis was confirmed by microscopic examination. He stated that he believed the arteriosclerosis was of long duration and involved all of the major branches of the coronary circulation. In some cases the lumens through which the blood should flow were so small that it was necessary to use a microscope to see them.

He described the arteries as being calcified which meant to him that the disease was of long duration, in excess of a couple of years. He described coronary insufficiency as a condition where an insufficient volume of oxygen bearing blood is supplied to the heart muscle to maintain it under various situations. This demand is increased when the heart has additional activity to perform. In his opinion, the arteriosclerosis found in the captain's heart was sufficiently advanced to result in coronary insufficiency. He also stated that it was possible to have a coronary insufficiency without a demonstrable thrombus or a hemorrhage in the plaque. Thrombosis was described as a plugging or clogging of the lumen with a clot, while a plaque hemorrhage occurs around the lumen into the arteriosclerotic process in the arterial wall. The hemorrhage enlarges the plaque and occludes the lumen so as to compromise the blood flow through the area. Both can result in an occlusion. He stated that angina pain prior to the accident cannot be established by pathological findings. He did not list a single cause of death in the captain's case because he stated the captain could have died from

either heart disease or traumatic injuries. He was asked to compare the captain's heart condition with conditions of persons whose cause of death was designated as an acute coronary insufficiency, and stated that in the absence of other injuries or other findings he would feel that the captain's death was due to coronary insufficiency.

The doctor described the fractures of the hands and arms of the two pilots and noted that the difference appeared to be that the first officer suffered fractures of both thumbs while the captain's thumbs were not broken but two fingers were. He was unable to express an opinion as to whether the captain was relaxed at the time of impact or that the first officer may have had control of the aircraft, based on the injuries each suffered in the crash.

Another pathologist, who had participated in autopsies of many aircraft accident victims, testified that there was without doubt coronary insufficiency present in the captain's heart. He further testified that his review of the captain's medical records showed that they reflected all the symptoms of a coronary insufficiency and the findings of the autopsy reinforced his opinion. He stated that it would not be possible to detect angina by pathological means. He also testified that if the traumatic injuries suffered by the captain had not been present, the captain's death would have been attributed unequivocally to coronary arteriosclerosis. In his opinion the probability of a patient with the captain's degree of arteriosclerosis having a coronary insufficiency and sudden death was quite high. He testified that given the circumstances under which the captain had been operating, in his physical condition, it was medically probable that the captain could have suffered anginal pains and that there is a reasonable medical probability that he may have experienced sudden death from coronary artery disease prior to impact.

He compared the injuries suffered by the captain and the first officer, with particular reference to the injuries they sustained to their upper extremities. He testified that it has been his experience that the injuries to the first officer's hands and arms were indicative of his hands being on the controls of the aircraft at the time of impact. Such injuries were not found on the captain's hands.

An aviation medical examiner, who was also a flight surgeon and cardiovascular specialist, testified he had reviewed the captain's medical record obtained from his personal physician. These records revealed that the first indications of coronary artery disease were reported in December 1947. From that time until 1950 there were many visits, the records of which presented increasing evidence, from a historical standpoint, that the captain was having difficulty with his heart. From 1950 until 1963 there is no record of any complaints about the patient's heart, but from 1963 until his last visit on April 11, 1966, there was an indication that the patient was having increasing symptoms that were related to his heart. The symptoms were primarily pain in the chest with radiation down the left arm, apprehension, and increase in heart rate. These symptoms were characterized as those that come from heart disease.

During the periods covered by the medical records reviewed, the captain received prescriptions for various medications including aminophyllin, nitroglycerin, and Peritrate. The nitroglycerin was to be taken for relief of pain at first but later the patient was advised to take them prophylactically to preclude the occurence of pain. From November 1963 on, the physician prescribed a dosage of four Peritrate tablets daily. The prescription records show that this prescription was filled 26 times during this period.

The records also revealed that from October 1962 until the time of the accident, the captain was being treated for diabetes with a prescription of 1/2 an Orinase tablet daily. The records show that this treatment apparently controlled the diabetes with only occasional sugar spilling being reported.

During these periods of treatment the captain was taking semi-annual FAA Class I flight physicals as a part of his airline pilot transport rating license requirements. A review of the medical history portion of the application completed by the captain shows that he always denied having had either heart disease or diabetes. He also denied, in the more recent applications, having consulted a physician or being under medication.

The witness testified that Peritrate is a drug that dilates the arterial system and it is believed that it dilates preferentially and better the coronary vessels than others. He was not aware of this drug being prescribed for anything other than cardiovascular disease.

He testified that nitroglycerin is also a dilator of the arterial system. Preferentially it dilates the coronary arteries and is a very rapid acting medication because it is rapidly absorbed and its effect is also rapidly dissipated. Ordinarily the patient is advised to have the tablets handy at all times and to take them at the first sign of discomfort. Also, if the patient knows certain activity would produce discomfort and knows under particular circumstances that he must carry out that activity, he might take the tablet prophylactically to prevent difficulty. He also testified that if the taking of Peritrate was discontinued, one might expect the patient would have more difficulty with pain.

He testified that when a patient suffered angina pain he would be handicapped in the performance of whatever he was doing, distracted by the discomfort, and on occasions actually incapacitated. He stated that there was a probability that a person with this type of severe coronary artery disease would suffer sudden death. Such an attack would probably include sudden unconsciousness, possibly within 7 to 12 seconds. This could occur under circumstances that would induce coronary insufficiency. He also testified that given the circumstances of this flight, with the captain in the condition he was, that it was very likely the patient would experience angina pains. Further, the possibility of sudden death would have been high in this patient.

A toxicologist testified at the public hearing regarding tests he performed on specimens taken from the captain's body. He also testified regarding his tests of two types of pills, a container of paper tape, and a small empty prescription bottle labled with the captain's name, which were recovered after the accident. There were no pills in the bottle, but there was a residue in the bottle which was analyzed. He was also supplied with a sample of embalming fluid used in embalming the captain's body.7/

The specimens from the captain's body were tested for determination of alcohol, carbon monoxide, acidic, basic, and neutral drugs, cholinesterase inhibitors, and blood sugar. The other materials were tested to determine the active ingredients in them and for identification of the tape.

He reported that there was no ethyl alcohol detected in the blood sample and there was only a trace of carbon monoxide. The embalming fluid contained

7/ The captain's body was embalmed before the autopsy was performed.

methyl alcohol, but not ethyl alcohol. No acidic drugs were detected in the blood or liver tissue. Traces of material having the properties of tolbutamide were obtained from the liver tissue but the quantity was insufficient for identification except by chromatograph RF and U V Spectrum. No neutral drugs including nitroglycerin were detected in the blood or liver tissue.

Examination of a "Tabloid" tablet revealed it contained salicylate, phenacetin, caffeine and codeine. The quantity of codeine is equivalent to the amount in a tablet containing one-half grain of codeine. Two other tablets did not contain opium alkaloids, saccharin or atrophine, but did give a positive test for the presence of nitroglycerin. The paper tape was identified as "Glucose Tes-Tape" normally employed for testing for sugar in the urine. The residue in the bottle contained salicylate, phenacetin, caffeine, and codeine.

He identified tolbutamide as an agent which a patient might take to influence the level of blood sugar. He attached no significance to the relatively low blood sugar reading in the captain's blood because of the type and number of injuries suffered by the captain.

Testimony taken during a previous aircraft accident investigation[8/] revealed that a heart with evidence of severe coronary arteriosclerosis and advanced coronary arteriosclerotic heart disease is identified by showing large areas of fibrous scarring. This is considered evidence of long standing previous disease. The scarring is caused by a lack of oxygen supplied to the muscle fiber which causes the muscle to die and be replaced by fibrous scar tissue. The period of time involved would be several months at least. People who suffer from arteriosclerotic heart disease or coronary arteriosclerosis are likely to suffer sudden collapse or death as a result of this condition. The witness testified, that in that case, a landing accident under instrument flight conditions, the possibility was very high that the pilot died of a heart attack. He stated that it is known that people who have advanced arteriosclerotic heart disease suddenly collapse and die of that particular disease, particularly under conditions of either physical or mental stress. He also testified that literature in aerospace medicine indicates that pilots who are landing or taking off in aircraft do have higher blood pressure during those periods and pilot stress is also indicated by increased pulse rate, increased respiration, and other symptoms, when compared with straight and level flight. He was unable to describe what action a person suffering such an attach might take but some victims double over forward, some people just grasp their chest and lean over backwards. There is no hard and fast rule.

A heart specialist testified, in the previous investigation, that it was possible for a person to have severe coronary artery disease and yet have a normal electrocardiogram. It would be possible for a patient to have this type of heart disease and an examining physician would not be able to detect it without the patient's cooperation. He also testified that coronary artery insufficiency may manifest itself by heart pain (angina pectoris) or may lead to certain conduction disturbances known as arrhythmias and may also lead to heart failure (myocardial infarction). Myocardial infarction may be manifested by pain, sudden shock or collapse, sudden episodes of loss of consciousness, palpitation, or estreme shortness of breath.

He testified that the best test to diagnose coronary heart disease is a history of angina pectoris with or without corroborative evidence of an

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8/ Flying Tiger, North Hollywood, California, December 14, 1962 - SA-369.

electrocardiogram. The actual establishment of heart pain is one of the most important tools in such diagnosis and the patient could, by failing to reveal a history of such pain, prevent the diagnosis.

A pathologist also testified in the previous investigation that in the absence of evidence of acute ischemia he was not in a position to state with certainty that the changes present caused pilot incapacitation. Persons with this degree of coronary arteriosclerosis are known to be subject to sudden death or incapacitation from acute coronary insufficiency. Any conclusion of pilot incapacitation must be based on gross and microscopic findings and a careful consideration of other corroborative evidence of the facts, conditions, and circumstances surrounding the accident.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The maintenance discrepancies discovered during the course of this investigation did not contribute to the cause of this accident. There was a lack of knowledge on the part of the company inspection and maintenance department with respect to the operation, servicing, and maintaining of the flight recorder. There was no training or course of instruction relative to the servicing of the flight recorder within the aircraft. Subsequent to the accident, these deficiencies were corrected.

The condition of the torquemeter pickups, the compressor sections and the turbine assemblies indicates that the four engines were rotating and developing power at impact. Although the TIT gage readings do not indicate the same horsepower level as determined by the propeller blade angles and true airspeed calculations, they do indicate a level of power. This difference is probably due to the continued operation of the fuel control system after initial impact occurred and while some electrical power was still available. The fast acting control would, in this time interval, change fuel flow and temperature. However, the combined results of the two independent examinations are valid indications of power development at impact.

All structural components were intact and capable of normal operation prior to initial impact. The landing gear was fully extended, and the flaps were extended 78 percent, indicating the crew had the aircraft in an approach configuration, with the intention of landing at Ardmore.

The crew had more than a casual interest in obtaining current weather conditions at Ardmore, as evidenced by their many contacts en route. At the time of the accident, an inverted trough extended from northeast to southwest, just a few miles west of the Ardmore Municipal Airport. Radar weather observations and photographs showed a line of thunderstorms and moderate rain showers which are considered to have been associated with the trough.

Although the ceiling and surface visibility conditions at the airport were officially reported above approved circling landing minimums, at the accident site, the ceiling could have been on the order of 100-200 feet sky obscured with 1/4 to 1/2 mile visibility in the very light rain showers and fog. The winds aloft at 1,000 and 2,000 feet m.s.l., were 140 to 150 degrees, 18-20 knots, and 160 to 170 degrees, 28-30 knots respectively. For several hours Ardmore had been reporting weather conditions which were very close to instrument approach minimums for the airport, and the crew became aware of this fact early in the flight.

At 2003, Flight 280/D was cleared to 7,000 feet following the crew's request for a lower altitude. Approximately 3 minutes later, a clearance to proceed via direct Duncan VOR, direct to the Ardmore Radio Beacon was received in accordance with the crew's request. The flight was also provided with the advisory concerning the location of radar-observed storm cells 15 miles west of Ardmore. The flight crew then advised their Ardmore estimate was 2028, and requested and were given the 1957 Ardmore weather.

At 2007, and for a period of 2 minutes and 25 seconds thereafter, the Fort Worth ARTCC attempted to contact Flight 280/D. It was during this time that the first officer had switched frequencies to obtain weather information from the Ardmore FSS specialist. Following the termination of his contact with the Ardmore FSS specialist, contact was again made with the Fort Worth ARTCC. During this time, the captain should have heard the Fort Worth ARTCC controller's call and acknowledged it. It is believed that the captain was also interested in monitoring the FSS transmissions and he did not hear the ARTCC calling. The flight was then cleared for an approach to the Ardmore Airport, radar service was terminated, and at 2018, the flight was requested to contact Ardmore Radio on 126.7 mcs. Except for the brief communications discrepancy, flight operations during the en route descent to the Ardmore Radio Beacon were routine.

At approximately 2019, Flight 280/D was 15 miles west of the Ardmore Radio Beacon at 5,000 feet, having been cleared to the Ardmore Airport to cruise at 5,000 feet. With this type of clearance, the flight was allowed to choose any approved type of approach into the Ardmore Municipal Airport and to descend at the pilot's discretion without further clearance from ARTCC.

At 2026, Ardmore Radio requested Flight 280/D's position and was advised they were over the beacon inbound. According to ground witnesses who observed or heard the original flight and watched and/or listened to the fly-bys, the aircraft passed approximately one mile north of the beacon and turned to the northeast establishing a track of approximately 071 degrees magnetic.

Under the provisions of the approach clearance issued to the flight, selection of the approach procedure to be utilized was left entirely to the pilot. The pilot's choice was an ADF approach, since he requested clearance to the Ardmore Radio Beacon shortly after they began their en route descent; before reaching the beacon they asked the FSS for lights on runway 8; and the flight reported to the FSS controller inbound over the Radio Beacon.

The probable reason for the pilot's decision to execute the ADF approach was that this procedure was the only one that authorized a straight-in approach and it provided the lowest weather minimums at Ardmore.

Utilizing ARTCC data, witness information, and simulated flight test data, the approximate flight of the aircraft was reconstructed. The significant factors revealed were: the track over the ground placed the aircraft approximately one mile north of the Ardmore Radio Beacon at the time of passage; the track from the beacon to the airport placed the aircraft about 1-3/4 to 2 miles north of runway 8, in an east-northeasterly direction; and the aircraft's altitude varied from 1,200 feet m.s.l. to 963 feet m.s.l. during the last minute and 15 seconds of flight.

Beacon Passage

There are several possible reasons for the aircraft passing one mile north of the Ardmore Radio Beacon, instead of over it, at station passage. The first was that the crew failed to correct for wind drift and allowed the aircraft to drift to the north. The second was that the ADF was malfunctioning; however, this could have been monitored with the use of the Ardmore VOR and DME backup, both of which were tuned to their respective frequencies and were operating satisfactorily up to impact, according to checks made subsequent to the accident. The third and most probable reason for being one mile north of the Ardmore Radio Beacon was that the crew of Flight 280/D, using airborne radar, was circumnavigating radar echo activity 12 to 15 miles west of the beacon as well as an isolated radar echo near the beacon, and that the flight deviated accordingly.

Magnetic Track

The aircraft's altitude at station passage should have been not less than 2,300 feet. The magnetic track from the Ardmore beacon to runway 8 was 076 degrees. It was calculated that Flight 280/D established a magnetic track after station passage of approximately 071 degrees. The aircraft was observed by a witness 1½ miles northwest of the airport at approximately 1,160 feet m.s.l., and the average winds from station passage to this witness location were from 170 degrees at 27 knots. This would have introduced a drift of 10 degrees to the left. Since the aircraft was tracking 071 degrees magnetic, the aircraft would have been flying on a magnetic heading of 081 degrees.

The magnetic heading of 081 degrees is 5 degrees farther right than the approach bearing of 076 degrees. It can be assumed that the crew turned to 081 degrees, attempting to correct for the one mile north deviation, and to intercept the 076-degree bearing. However, because the winds were stronger than they anticipated, approximately 10 degrees of left drift was encountered and the approximate magnetic track of the aircraft became 071 degrees.

Descent Below Minimums

The aircraft's descent path, just prior to impact, was determined to be approximately 7.2 degrees and the calculated wing attitude was approximately ten degrees right-wing down at impact. Using this angle of descent and an airspeed of approximately 150 knots at time of impact, the aircraft would have had an average descent rate of 1,950 feet per minute. A loss of 197 feet (1,160 feet down to 963 feet) at this rate of descent would take approximately 6 seconds.

Flight 280/D should not have descended below 1,362 feet m.s.l., unless the aircraft was clear of clouds. It has been determined that the aircraft did descend to approximately 1,160 feet, at which altitude it was observed north of the airport, and it crashed at 963 m.s.l. Since the ceiling was reported to be ragged, it is believed the crew descended below 1,362 feet in order to maintain visual flight and remain clear of clouds. The only obstruction within 5 miles of their approach path higher than 1,160 feet was a radio tower located 5 miles north of the beacon which was 1,579 feet m.s.l. The highest obstruction in the vicinity of the airport was located 2 miles north of the airport and was 1,075 feet above m.s.l. This was a tower located atop the Arbuckle Mountains which had an average terrain elevation of 1,000 feet m.s.l.

Two miles northwest of the airport, the aircraft was sighted by a witness. Ground witnesses indicate Flight 280/D continued to track approximately 071 degrees magnetic until it was one mile north of the airport boundary. At this time and position, the FSS specialist at Ardmore had the aircraft in sight, and the crew requested a change of lights from runway 8 to runway 12.

Based on the identification of the first officer's voice on the radio and common custom and practice in air carrier operations, the Board concludes the captain was flying the aircraft.

The captain knew his position when the request was made to change the lights and being familiar with the terrain surrounding the airport, he would not have intentionally descended below the altitude of 1,160 feet m.s.l. If the crew had encountered cloud conditions or rain which obscured their visibility, the captain or the first officer would not have intentionally allowed the aircraft to descend below 1,160 feet m.s.l., while over the Arbuckle Mountains.

As to why the aircraft was permitted to descend to 963 feet m.s.l., the Board can rule out malfunction of the control system, airframe failure, powerplant failure, interference with the crew by unauthorized persons, and altimeter error, since the evidence of the investigation established that none of these factors existed.

It has been established that power was applied and the aircraft was rotated noseup immediately prior to impact. This is confirmed by physical evidence at the scene and by the statements of several surviving passengers. There was no mention of a negative "g" force or pushover in the last few seconds prior to impact by these same survivors. The Board believes the sharp left turn described by surviving passengers was the motion associated with a pilot rolling out of a turn to the right to regain a level flight attitude rather than a turn to the left from a level flight attitude. With no outside reference on which to base the attitude of the aircraft the passengers would not be able to tell which occurred, but the attitude of the aircraft, right-wing down at impact, indicates that the aircraft was more likely rolling out of a turn to the right than into a turn to the left.

An intentional descent at 1,950 feet per minute for the last 6 seconds of flight could have been the result of spatial disorientation, an attempt to maintain visual flight and keep the field in sight, or pilot incapacitation.

Spatial disorientation might conceivably have resulted while the captain was trying to keep the airport in sight, and he may have assumed the aircraft was in a climbing maneuver. His reaction to this type of disorientation would be a definite pushover of the yoke. This would have introduced a negative "g" force which would have been felt by passengers. None of the surviving passengers felt a negative "g" force of this magnitude during the last few maneuvers prior to impact and therefore the Board concludes that spatial disorientation did not initiate the accident sequence.

Concerning the attempt to maintain visual flight, it is very doubtful that the captain would push the aircraft over in order to keep the field in sight because of the high terrain in this vicinity. Even if this had been done, power addition and rotation would not necessarily have been utilized. It would have been impossible to see the hills or trees at night because of the lack of

lighting and the adverse weather conditions. It is concluded that the captain would not intentionally descend below 1,160 feet m.s.l., in order to keep the field in sight on encountering cloud conditions.

The evidence points toward the probability that Captain Pigman became incapacitated prior to the last 6 seconds of flight and the aircraft went into an uncontrolled descending right bank. A pathologist who participated in the investigation and who has performed autopsies on over 2,000 air-crash victims stated that the fractured condition of the first officer's hands and arms was of such a nature that it indicated he had control of the aircraft and had his hands on the controls at the time of impact. Further, evidence revealed that the captain did not have comparative or similar fractures on his hands and arms.

It is probable that the captain entered a standard rate turn to the right in preparation for making a downwind leg for landing on runway 30. While turning through a heading of 142 degrees, the captain may have collapsed permitting the aircraft to enter a sink rate of 1,950 feet per minute.

The first officer, who was probably looking out the right window and keeping the field in sight, may have been warned of the event by the flight engineer, or noticed the change in attitude. His immediate reaction would have been to grab the control wheel and order more power. It would take approximately 3 to 5 seconds for the first officer to effectively respond and grasp the controls. An additional 1.5 seconds would be required for the aircraft to respond and rotate through an attitude of 12 degrees. Since it would take approximately 6 seconds to descend from 1,160 feet to 963 feet, the first officer would be unable to prevent a collision with the ground under these conditions.

The Board, after reviewing all the evidence relating to the captain's physical condition and medical history, the cardiologists' testimony not only in this but in another case, and the environment in which the captain was functioning, concludes that he became incapacitated during the final stages of the approach. Whether the captain slumped over the wheel, rolled slowly into an excessive rate of bank, or fell back in the seat allowing the aircraft to roll slowly into a bank, with no back pressure applied to the controls, cannot be determined. However, if any of these situations did occur while the first officer's attention was distracted by attempting to keep the airport or runway in sight, the results would be very much the same. The time necessary for the first officer to see and recognize the problem and take corrective action, coupled with the response time of the aircraft to the corrective action, was more than the time available for recovery, and the result was impact with the ground.

Consideration was given to the possibility that downdraft turbulence from a thunderstorm located directly over the accident site caused a rapid loss of altitude and impact with the ground. We can find no evidence of a thunderstorm in the area of the accident other than the one reported near the radio beacon, approximately 6 miles from the accident site. Additionally, had the crew been resisting the effects of a downdraft at the time of the accident, the aircraft's attitude would have been nose high rather than nose low as found in this case.

2.2 Conclusions

a. Findings

1. All structural components were intact and capable of normal operation prior to initial impact.

2. The powerplants were developing power at impact and were not a factor in this accident.

3. The flight recorder was not properly checked, maintained or serviced and was not operating during the last flight. This was not a causal factor in this accident.

4. The aircraft was within weight and balance limitations.

5. The flight was provided with current weather reports and it is concluded that while thunderstorms in the area may have affected the flight's progress, thunderstorms are not in direct causal relationship to the accident.

6. The first officer and flight engineer were properly certificated for this flight.

7. While the captain was properly certificated for this flight, the FAA would not have issued him a medical certificate had they been aware of his true medical history.

8. Captain Pigman had a history of heart trouble extending back 18 years, and a history of diabetes extending back 3½ years.

9. Because the first officer was operating the radio in the terminal area, the Board believes the captain was flying the aircraft during the attempted instrument approach.

10. The captain failed to complete a straight-in ADF approach to runway 8. This failure was probably a result of his efforts to avoid a thunderstorm in the vicinity of the radio beacon.

11. After failing to complete the approach to runway 8, he flew north of the airport proceeding to an approach and landing on runway 30.

12. While attempting a right turn the captain experienced a coronary insufficiency and became incapable of controlling the aircraft causing the aircraft to descend rapidly towards the terrain.

13. The low altitude and high rate of descent precluded a safe recovery by the first officer.

14. The captain and first officer had been aloft approximately 11 hours during 16 hours duty time. While this time is not in excess of appropriate crew rest requirements, the Board believes the 16 hours of duty time contributed to the captain's susceptibility to incapacitation.

The Board is concerned by the fact that the captain, who in this instance was also the president of the air carrier, had an established medical history of cardiovascular disease and diabetes mellitus, both of which are disqualifying for the issuance of a first-class medical certificate, and that he deliberately falsified his application for this certificate. We are aware that cardiovascular disease and diabetes mellitus could remain undetected during the course of a first-class medical examination. There have been numerous instances where a flight crewmember has become incapacitated from cardiovascular disease while at the controls of an air carrier airplane or just subsequent to flight.

The failure of the pilot of Flight 280/D or any pilot exercising commercial privileges to disclose his total medical history by falsifying his application for a medical certificate, places in jeopardy the lives of not only those passengers aboard an aircraft but the lives of the crewmembers as well.

The Board, in conjunction with the FAA, is exploring ways to improve the quality of medical information received from pilots, is attempting to improve the state of the art of medical diagnoses of pilots, and is exploring the possibility of removing legal restraints which prevent physicians from reporting information of importance to the maintenance of aviation safety. (See Attachments 2 and 3.)

b. Probable Cause

The Board determines the probable cause of this accident was the incapacitation, due to a coronary insufficiency, of the pilot-in-command at a critical point during a visual, circling approach being conducted under instrument flight conditions.

BY THE CIVIL AERONAUTICS BOARD:

/s/ CHARLES S. MURPHY
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

/s/ JOHN G. ADAMS
Member

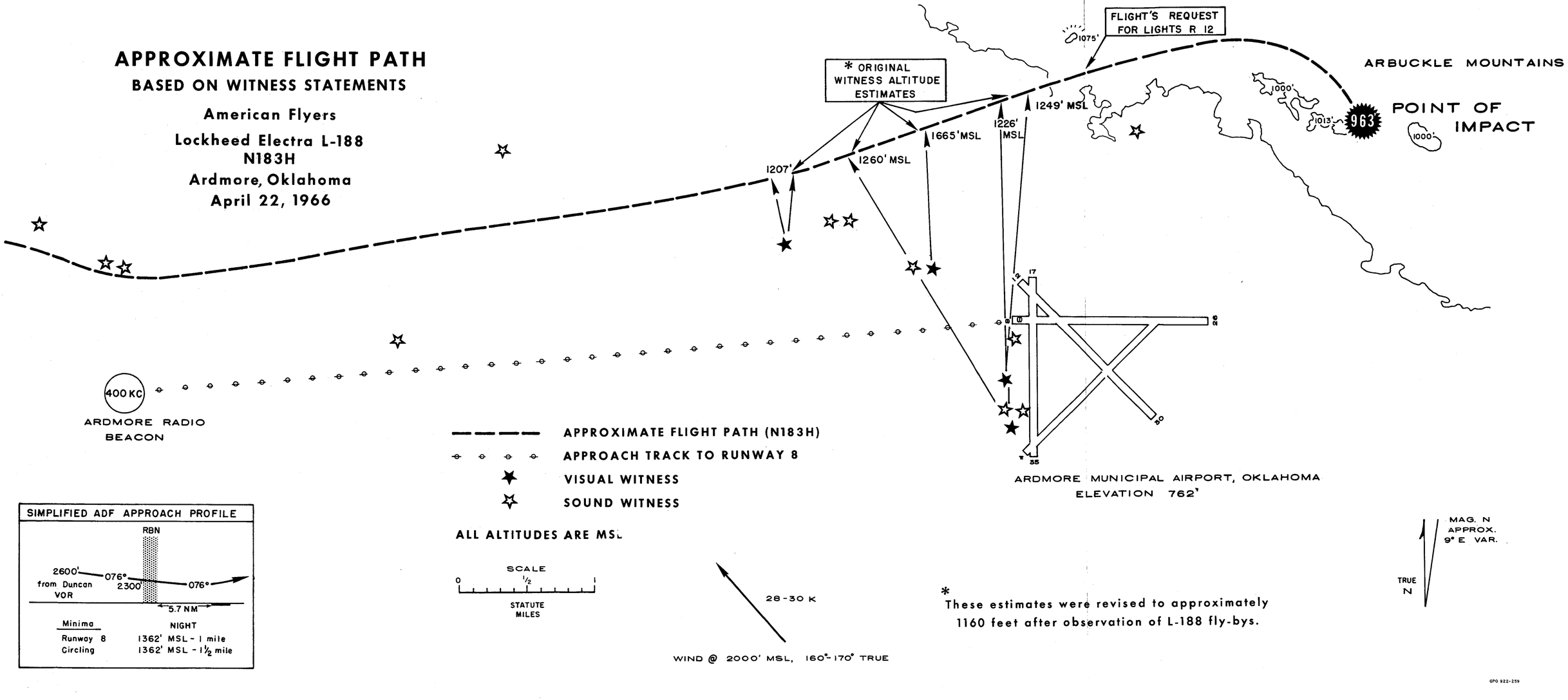
ATTACHMENT 1

APPROXIMATE FLIGHT PATH

BASED ON WITNESS STATEMENTS

American Flyers

Lockheed Electra L-188
N183H
Ardmore, Oklahoma
April 22, 1966



SIMPLIFIED ADF APPROACH PROFILE

Minima	NIGHT
Runway 8	1362' MSL - 1 mile
Circling	1362' MSL - 1½ mile

* These estimates were revised to approximately 1160 feet after observation of L-188 fly-bys.

GPO 922-259

ATTACHMENT # 2

C O P Y

CIVIL AERONAUTICS BOARD
Washington, D. C. 20428

Honorable William F. McKee
Administrator
Federal Aviation Agency
Washington, D. C. 20553

May 5, 1966

Dear General McKee:

Our investigation of the fatal accident involving American Flyers Airline Corp., on April 22, 1966, has revealed a situation which we feel requires a review of the general procedures that apply to examining an applicant for an airman's medical certificate.

The captain involved in this accident had an established medical history of cardiovascular disease and diabetes mellitus dating back to 1963. Both of these conditions are disqualifying for the issuance of a first-class medical certificate. It is interesting to note that the captain had successfully completed a first-class medical examination on February 22, 1966. We are aware that cardiovascular and diabetes mellitus could remain undetected during the course of a first-class medical examination. However, these conditions must have been detected by clinical diagnosis in the past, since the Regional Flight Surgeon, Doctor Gibbons, during an interview with the captain's physician, determined that the captain had been on certain drugs for approximately three years (nitroglycerine) for the treatment of cardiovascular disease.

Unfortunately, this finding cannot be considered an isolated case. It appears that cardiovascular disease is a continuing problem in aviation safety. Although the Board has attributed the probable cause of only one air carrier accident to this disease, Flying Tiger Line L-1049A at Burbank, California, on December 14, 1962, it has been suspect on other air carrier accidents, such as Allegheny Airlines, Martin-202 at Williamsport, Pennsylvania, December 1, 1959; Delta Air Lines Convair-880 at Atlanta, Georgia, May 23, 1960, and Flying Tiger Line L-1049 at San Bruno, California, December 24, 1964.

There have been a number of instances where a flight crew member has become incapacitated from cardiovascular disease while at the controls of an air carrier airplane or just subsequent or prior to a flight. Our records contain the following instances:

Date	Location	Carrier	Aircraft	Type of Incident
12/22/61	Idlewild, New York	NAL	DC-6	Captain died while deplaning
11/28/62	Hartford, Connecticut	MOH		Captain died shortly after deplaning

C O P Y

C O P Y

Honorable William F. McKee (2)

Date	Location	Carrier	Aircraft	Type of Incident
7/14/62	Prestwick, Scotland	FTLX	L-1049	Copilot expired during flight
11/16/62	Yucatan, Mexico	PAWA	DC-8	Captain suffered fatal heart attack during flight
6/2/63	Anchorage, Alaska	NWA	DC-8	Captain suffered fatal heart attack
9/26/65	O'Hare, Illinois	DAL		Pilot suffered fatal heart attack getting aboard aircraft
10/18/64	Hector, California	WAL	DC-6B	Captain suffered fatal heart attack during flight
2/25/66	O'Hare, Illinois	BNF	BAC-111	Captain suffered fatal heart attack during landing roll

In addition to the aforementioned air carrier accident, our records on general aviation accidents indicate that a heart condition either caused or was suspected in five cases in 1959, seven cases in 1960, six cases in 1961, three cases in 1962, one case in 1963, five cases in 1964, and ten cases in 1965.

In view of the foregoing, we recommend that methods of detecting medical deficiencies be reviewed to ascertain whether it is possible and practicable to improve such methods of detection, particularly during first-class medical examinations.

This matter has been coordinated with Mr. Arvin O. Basnight, Associate Administrator for Programs. Representatives of our Bureau of Safety will be available for further coordination, if so desired.

Sincerely yours,

/s/

Chairman

C O P Y

C O P Y

ATTACHMENT # 3

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

May 23, 1966

OFFICE OF THE
ADMINISTRATOR

Dear Mr. Chairman:

This is in reply to your letter of May 5, 1966, in which you discuss the preliminary findings of investigation of the accident on April 22, 1966, involving an aircraft of American Flyers Airlines Corporation. In your letter you recommended that methods of detecting medical deficiencies be reviewed to determine if it is possible to improve methods of detection, particularly with regard to potentially incapacitating heart conditions.

This matter has been considered at some length by our Office of Aviation Medicine. Pertinent aspects of this problem have been brought together in some detail in the enclosure to this letter. It also deals with possible courses of action to be explored further. We believe it would be desirable to have a discussion between members of our respective staffs after you have had an opportunity to review this document.

The problem of early detection of coronary disease is, of course, one that confronts the medical profession in general. Unfortunately the state of the art of diagnosing this condition leaves a great deal to be desired, particularly in consideration of our responsibility to assure that pilots are physically able to perform their duties with safety.

It is clear to me that, had we known as much about the medical condition of the pilot of the American Flyers aircraft as he and his physician knew, we would have declared him ineligible to hold an airman certificate. Failure of the pilot to disclose this information, by falsification of his applications for medical certificates, denied us the most important tool for the diagnosis of these conditions, namely, an accurate medical history.

This suggests to us a possible course of action to improve the quality of the medical information we receive for pilots. Treating physicians are now under an obligation to their patients not to reveal to others information they obtain in the course of the physician-patient relationship. We are exploring the possibility of seeing to the removal of any legal restraints which now prevent physicians from reporting, in the public interest, information of vital importance to the maintenance of aviation safety.

C O P Y

We look forward to further discussions with your staff on the above and on other actions which might be taken to reduce the possibility of pilot incapacitation as a cause of aircraft accidents. Mr. Arvin O. Basnight, Associate Administrator for Programs, and Dr. P. V. Siegel, Federal Air Surgeon, will serve as my representatives for such discussions.

Sincerely,

/s/

WILLIAM F. McKEE
Administrator

Enclosure

Honorable Charles S. Murphy
Chairman, Civil Aeronautics Board
Washington, D. C. 20428

C O P Y

C O P Y

CORONARY DISEASE AND AIR CARRIER AIRCRAFT ACCIDENTS

May 19, 1966

I. Relationship of Coronary Disease Found at Autopsy to Accident Causation

A. Historical considerations.

1. Medical investigations of aircraft accidents were initiated by FAA in late 1959. Case accumulation just a little over six years.

2. There is no knowledge of the magnitude of the problem prior to 1959.
   a. We cannot determine if the problem is increasing.
   b. We cannot evaluate the effect of the electrocardiographic examination requirement which became effective in 1959.

3. Since medical data is so new to the accident investigation program, there is a need to put it in proper context with other investigation data.

B. Significance of autopsy finding of coronary disease.

1. Extensive coronary occlusive disease is often found at autopsy in deaths due to other causes.

2. In most cases no detectable pathological changes occur as evidence that incapacity existed or death occurred prior to an immediately succeeding fatal trauma.

3. The probability that incapacitation from coronary disease was the cause or contributing factor in an aircraft accident (in the absence of survivors or witnesses of the incapacitation) can be established only by the exclusion of all other probable causes. Only very rarely can the autopsy or other evidence establish this with medical certainty.

II. Regulatory Requirements, Certification and Review Systems

A. Medical standards for coronary disease.

1. The presence of coronary disease or history of symptoms or other evidence of coronary disease, by regulation (FAR 67), disqualifies a pilot from receiving medical certification and exercising pilot privileges.

C O P Y

2. Holders of First Class medical certificates (required for exercising ATR privileges) must have an electrocardiographic examination at the first examination after the age of 35 and annually after the age of 40.

B. Certification practices pertinent to the detection of coronary disease.

1. Reporting requirements--application form completed by applicant under penalty of fine and/or imprisonment for falsification.
   a. Use of medication, type and purpose.
   b. Past or present heart trouble.
   c. Rejection for life insurance, military service, etc.
   d. Any medical treatment within 5 years preceding application.

2. Review of examination results.
   a. Any history or physical findings suggesting the presence of heart disease or history of heart disease is followed by obtaining all pertinent records and complete cardiovascular examination by a heart specialist.
   b. Electrocardiograms (when required by regulation) are read by Agency medical specialists.
   c. Any significant EKG abnormality found (especially any evidence suggestive of coronary disease) is followed by complete cardiovascular examination by a heart specialist.

3. When a history or other evidence of coronary disease is medically confirmed the applicant is denied medical certification.

4. Airman appeals systems.
   a. Petition to FAA Administrator for exemption from regulations (FAR).
      1) Only one airline pilot with history of coronary disease has obtained an exemption which would permit serving as a pilot in air carrier passenger operations.
      2) Several exemptions have been issued limiting pilot to air carrier cargo operations only.
   b. Appeal of the Administrator's denial to the Civil Aeronautics Board.
      1) In the past 5 years the CAB has ordered the issuance of First Class medical certificates to at least 3 airline pilots for whom the Administrator had denied certification because of the diagnosis of coronary disease.

2) 4 pilots other than airline pilots with a diagnosis of coronary disease were issued medical certificates on order of the CAB in the past 5 years.

III. Probability of Pilot Inflight Death Due to Coronary Disease, and Experience to Date

A. Statistical estimation of frequency of death of airline pilots in flight.

1. Basis for estimation.
   a. Pilot age distribution.
   b. Average annual flight time per pilot.
   c. Incidence of sudden death due to coronary disease in all U. S. white males of similar age distribution.

2. Conclusion--approximately 3 U. S. pilots will die in flight in air carrier operations each year.

B. Cases of reported airline pilot deaths due to coronary disease.

1. 8 deaths in flight, since 1952.

2. 9 deaths either just before or just after flight, since 1956.

IV. Detection of Coronary Disease in Pilots

A. History of symptoms or other evidence of coronary disease.

1. The most important indication of its existence.

2. Frequently known by a treating physician.

3. More likely to be known by airlines which have medical departments.

B. Examining procedures.

1. Periodic standard electrocardiogram (now required).

2. Exercise electrocardiogram.

3. Angiocardiogram.

4. Vectorcardiogram.

5. Ballistocardiogram.

V. Possible Improvements in Detection

A. Improvements in obtaining history.

1. Reporting by treating physician.
   a. The status of a physician's legal responsibility to the patient versus responsibility to the public is not well established. Generally a physician is liable to suit if information is released without the patient's consent.
   b. The desirability of obtaining immunity to suit by state legislative action could be explored.

2. Increased medical surveillance by airlines.
   a. Airlines with medical departments could increase the scope of medical coverage.
   b. Airlines without medical surveillance could establish a surveillance program.

3. Obtaining medical information in possession of airlines.
   a. This is now prohibited by union/management agreements.
   b. This would probably reduce the rate at which pilots consult medical departments if mandatory reporting to FAA is required. Therefore, the benefits of a preventive and supportive approach to pilot health could be adversely affected.

4. Rigorous, publicized enforcement action for falsification of the medical application should have a deterrent effect on pilots who might otherwise consider concealing information.

B. Additional examination requirements.

1. Greater frequency and greater coverage of standard electrocardiographic examination.
   a. Electrocardiograms could be required of all air carrier air crew.
   b. The schedule for the electrocardiographic requirement could be made more demanding. An EKG could be required at the first application for medical certification after entering air crew employment, at age 25, at age 30 and annually after age 35.

2. Exercise electrocardiography.
   a. At least one airline with a medical department now requires an exercise EKG at time of hiring, at age 35 and annually after age 40.

b. There are technical difficulties due to the lack of standardization of EKG instruments, which results in false positive exercise test results.
c. The criteria for interpretation of results are not standard.
d. There is no agreement among experts as to the value of this technique in screening for coronary disease.
e. If used, it should probably only be performed and interpreted by those few experts in the country who have become established as competent in the use of this technique.

3. Vectorcardiography.
   a. Such examinations are generally available at only the most sophisticated medical centers.
   b. In general it gives no significant information not already available from careful reading of a standard EKG.
   c. Few experts are proficient in this technique.

4. Angiocardiography.
   a. Such examinations are available only at the largest and most sophisticated medical centers.
   b. Only a handful of experts are proficient in the use of this technique.
   c. It involves threat to life even when performed by experts.
   d. Its value as a screening technique has not been fully established.

5. Ballistocardiography.
   a. No standardized technique has been generally adopted.
   b. It shows promise but needs more experimental work.
   c. It is available at very few medical facilities.
   d. Only a few experts are capable of making interpretations of the results.

VI. Summary

A. Prevalence of coronary disease and its complications.

1. Coronary disease is the most common cause of death in U. S. males.

2. Approximately 60 percent of males in the 40-60 year age range have evidence of coronary disease on autopsy. Many at younger ages have similar findings.

3. Between 40 and 60 percent of persons who suffer a heart attack due to coronary disease have no prior history of symptoms or other evidence of the existence of the disease.

4. Persons with a history of a prior heart attack or other evidence of coronary disease are 10 times more likely to die suddenly than persons, in the same age group, in whom there has been no indication of coronary disease.

B. Areas of possible FAA action to improve detection.

1. Improvement in medical history.
   a. Rigorous prosecution for falsification of the application for medical certificate.
   b. Promotion of state legislation which would permit treating physicians to report to FAA concerning potentially incapacitating disease in their patients who are pilots.
   c. Promotion of greater medical surveillance by airlines.
   d. Education of practicing physicians concerning the possible consequences of such diseases in their pilot patients.

2. Improvement in diagnosis.
   a. The possibility of requiring electrocardiographic examination more frequently will be explored.
   b. Other existing and developing diagnostic techniques will be explored for feasibility of application as screening devices. None of these appear to be appropriate for this use at this time.

3. Possible regulatory actions.
   a. Employers of pilots (airlines) could be assigned responsibility to ensure their pilots meet medical regulatory requirements.
   b. When practical means for better detection of coronary disease are identified they will be made the subject of regulatory requirements.